

PATENT ABSTRACTS OF JAPAN

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(71)Applicant : TOSHIBA CORP

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(72)Inventor : TAMURA KUNIO

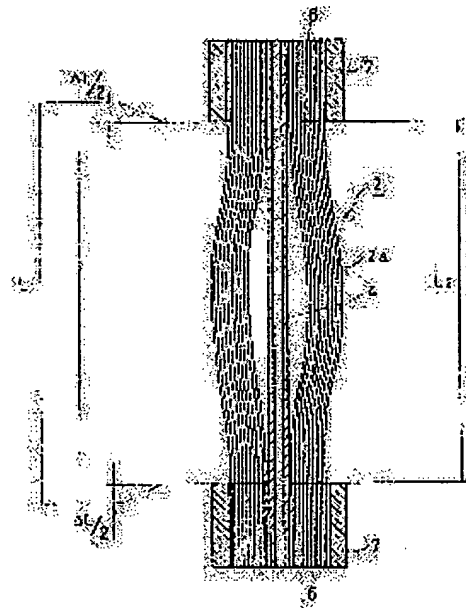
(54) HOLLOW YARN MEMBRANE FILTER

(57)Abstract:

PURPOSE: To prevent the damage of a hollow yarn and to perform effective backwashing, by a method wherein hollow yarns are arranged so that the length of each of the hollow yarns between both adhesive filling parts is so excessive as to satisfy a specific condition with respect to the interval between both adhesive filling parts.

CONSTITUTION: In a hollow yarn membrane filter 2, the length L_1 of each of the hollow yarns 2a arranged in a slightly loosened state between upper and lower end adhesive filling parts 6 is set so that an excessive length ΔL satisfies the relation $0.01 \leq \Delta L/L_1 \leq 0.04$ (wherein $\Delta L = L_1 - L_2$) with respect to the distance L_2 between both

adhesive filling parts 6. By this method, the whirling-up of the hollow yarns 2a at the time of backwashing and the accompanying entanglement, bending or breakage can be prevented and, since the hollow yarns 2a are shaken properly, effective backwashing can be performed. Further, a solid component released at the time of backwashing is not accumulated in the hollow yarn membrane filter 2. Furthermore, a liquid effectively flows around the hollow yarns 2a positioned at a central part at the time of filtering.



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(71) Applicant: TOSHIBA CORP

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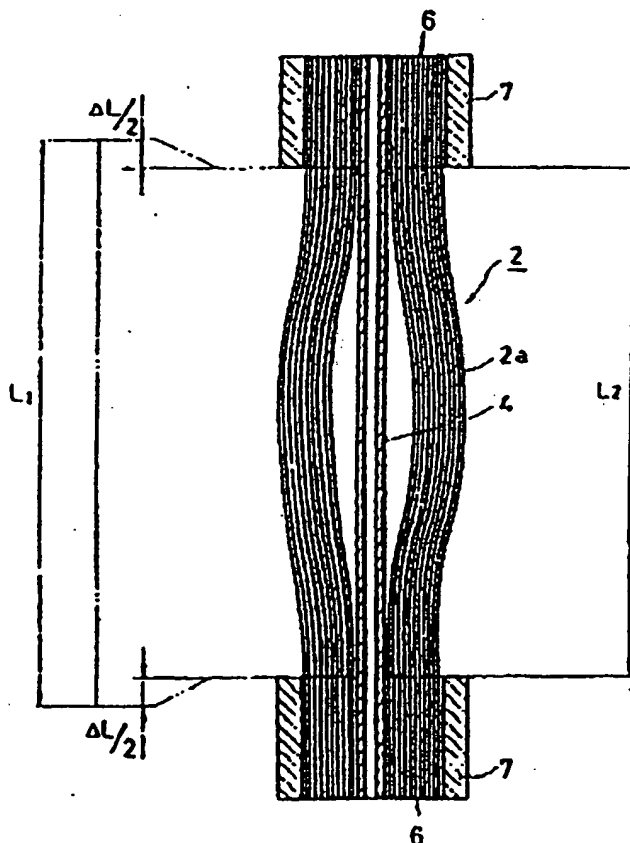
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⑩ 発明の名称 中空糸膜フィルタ

⑪ 特 願 昭61-202045

⑫ 出 願 昭61(1986)12月8日

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明 細 書

1. 発明の名称

中空糸膜フィルタ

2. 特許請求の範囲

適量の中空糸を溶着してその両端部を閉口するように隔壁部を形成して固定し、上記隔壁部を形成した隔壁部充填部の外周に隔壁固定部材を設けて固定して上記隔壁部を隔壁部充填部を所定長さをもって連続する中空糸膜フィルタにおいて、上記隔壁部充填部の中空糸の長さ(L₁)は上記隔壁部充填部の間隔(L₂)に対して所定の余長(ΔL)を有して配設され、この余長(ΔL)は以下の条件を満たすものであることを特徴とする中空糸膜フィルタ。

$$0.01 \leq (\Delta L / L_1) \leq 0.04$$

但し

L₁: 隔壁部充填部に配設される中空糸の長さ

L₂: 隔壁部充填部の間隔

$$\Delta L: (L_1 - L_2)$$

3. 発明の詳細な説明

【発明の目的】

（産業上の利用分野）

本発明は各種プラントの水処理装置にあって、濾過装置中の固形物を分離・除去する目的で使用される中空糸膜フィルタに関する。

（従来の技術）

一般に中空糸はその外径が0.3～1mm程度で、その両面に微細な穴を有する中空円筒状の構造の膜である。そして単位面積内の透過面積を大きくとることができるとともに、耐圧性に優れているという特徴を備えている。そこで中空糸を多数本取ってその両端を隔壁部である側面にて固めることによりフィルタを形成する。この中空糸膜フィルタを水処理装置用の濾過装置として使用する。

以下図5図を参照してそのような中空糸膜濾過装置の構成を説明する。図5図は中空糸膜濾過装置の断面図であり、図中符号1は容器本体である。この容器本体1内は仕切板3により上下に二分されており、下部空間を濾過室10とし、上部空間

を絶縁層11としている。上記絶縁層11内には中空系膜フィルタ2が上記仕切板3より露下されている。上記中空系膜フィルタ2は支持体4の外周に多量の中空系2aを充填させて、その上端部及び下端部を流着層完成部6で固定するとともに、更にその外周から流着層固定部7を流着して固定した構成となっている。また第1層に示す状態では上記構成をなす中空系膜フィルタ2を絶縁層11の2層構造としており、図中符号8はその層使用される流着層である。上記層11の下端部には絶縁層14に連通する流着層配管10が接続され、一方上端部には流着層配管11が接続されている。上記流着層配管10には開閉弁12が介挿されており、流着層配管13が接続されている。この流着層配管13には開閉弁14が介挿されている。上記流着層配管10を介して流着層11内に充填された後は、中空系膜フィルタ2を通過する際に通過されて各中空系2aの中空部を介して流出される。

いる。また図中符号21は流着層11において、この層11によって上送したバブリングの泡の気泡を中空系膜フィルタ2内に効果的に導入するものである。

ところで上述した構成の中空系膜フィルタ2に対して気泡を流す際、流着層の流着層完成部6によって決定される両隔壁の距離(第5図中符号12:示す)に対して、その間に配置される中空系2aの長さ(11、上記11:なる隔壁の間で若干始まっているので11より大きな値である)をどの程度の間隔をもって決定すれば、前述したバブリングが効果的になされかつ中空系2aの流着層が防止できらぬについては考慮されていないのが現状である。従来は5%程度の余長をもって決定していた。ところが、流着・流着を繰返すうちに中空系2aの長さ(11)が若干縮小する、あるいは中空系2aが高分子材料からなり、流着層の主成分である水とその比が多少変化する、中空系2aが長いとバブリング・流着に乏しいものと考えられる。このよう

上記構成において、流着により中空系膜フィルタ2の両隔壁の流着が上昇して、これが隔壁間に通した場合には、流着層を流して各中空系2aの両隔壁に付着した固形分を洗い落とす操作が行われる。すなわち流着層配管11を介して中空系膜フィルタ2の各中空系2a内に流着層の気泡を供給する。それと同時に中空系膜フィルタ2の下方からバブリング操作を施す。つまり流着層配管11内において中空系膜フィルタ2の下方にはバブリング管15が設置されており、このバブリング管15の下面部には気泡孔16が形成されている。また上記バブリング管15は開閉弁18を有するエア・供給管17に接続されている。そして上記バブリング管15に上記エア・供給管17を介してエアを供給することにより気泡孔16より気泡を発生させる。気泡により中空系膜フィルタ2をバブリングさせて流着層を剥離する。尚、図中符号3の下方位置の層11にはオーバーフロー管19が接続されており、該オーバーフロー管19には開閉弁20が介挿されて

な問題を解決する手段としては、前述5%程度に決定した余長を短くする、あるいは長くすることが考えられる。しかしながらその様な方法をとった場合には以下のような問題が生ずる。

- ①まず前述したバブリングを行なう際の中空系2aの流着層が必要以上に制限されて、十分なバブリング効果を得ることができない。
- ②中空系膜フィルタ2は前述したように流着層の中空系2aが非常に密に配置された状態で流着されており、余長を少なくすると、各中空系2a間に流着層が効果的に流着せず、よって中空系膜フィルタ2の外周に配置する中空系2aのみが流着に供される状態となる。これは流着層の両方から好ましくなく、又外周に配置する中空系2aのみに固形分が付着するという現象が発生してしまう。
- ③また流着を流した場合に、流着層により制限した固形分が中空系2a内に通ってしまい、制限した固形分の排出が効果的に行われにくいという問題がある。これも結局上記と同様に中空系2aが非常に密に配置されかつ余長が少ないため中空系

2. 図における透過率が悪いことによる。

(発明が解決しようとする課題点)

このように従来の中空系膜フィルタにあってはその余長をいかに設定するかについての十分な検討がなされておらず、その結果種々の問題を引起しており、本発明は以下の点に基づいてなされたものでその目的とするところは、中空系の破損を防止するとともに高効率な選別を行なうことを可能とする余長を備えた中空系膜フィルタを提供することにある。

(発明の構成)

(課題点を解決するための手段)

すなわち本発明による中空系膜フィルタは、従来の中空系を構成してその両端部が開口するように接着剤を充填して固定し、上記両端部を充填した接着剤充填部の外周に固定部材を固定して固定して上記両端部の接着剤充填部を所定長さをもって連続する中空系膜フィルタにおいて、上記両端部充填部の中空系の長さ(L₁)は上記両端部充填部の間隔(L₂)に対して所

定の余長(ΔL)を有して固定され、この余長(ΔL)は以下の条件を満足するものであることを特徴とするものである。

$$0.01 \leq (\Delta L / L_1) \leq 0.04$$

但し

L₁: 両端部充填部間に固定される中空系の長さ

L₂: 両端部充填部間の間隔

$$\Delta L: (L_1 - L_2)$$

(作用)

中空系の余長を上記範囲内とすることにより、余長が大き過ぎる為に見生ずる中空系のかうみつき、それによる屈曲・破損を減くするとともに、余長が小さ過ぎることにより見生ずる選別液の低下等の問題を効果的に解決するものである。

(実施例)

以下第1図乃至第4図を参照して本発明の一斑態例を説明する。両図系と同一部分には同一符号を付して示しその説明は省略する。第1図は中空系膜フィルタ2の構成を示す断面図であり、上

述及び下述の両端部充填部間に若干の隙間を有して固定される中空系2. の長さ(L₁)は、上記両端部充填部間の間隔(L₂)に対して(ΔL)なる余長を有しており、この余長(ΔL)は以下の範囲内に設定されている。0.01 ≤ (ΔL / L₁) ≤ 0.04 — (I)

但し

L₁: 両端部充填部間に固定される中空系の長さ

L₂: 両端部充填部間の間隔

$$\Delta L: (L_1 - L_2)$$

余長(ΔL)をこのように範囲内に設定したのは、余長が大き過ぎることによる弊害、及び余長が小さ過ぎることによる弊害の両方を効果的に排除するためであり、以下第3図及び第4図を参照して説明する。

第3図は従来に余長(ΔL)の中空系2. の長さ(L₁)に対する割合をとり(%)、従来に中空系2. の両端部本位(中空系100本位)をとって示した図である。これによると、余長(ΔL)

の中空系2. の長さ(L₁)に対する割合が1以下の場合には屈曲破損が生じた中空系2. の本数が極めて少ないことがわかる。よって余長(ΔL)割合を1以下にすれば余長が大き過ぎることによる弊害を効果的に減くすることができる。一方下屈曲であるが、これについては第4図を参照して説明する。第4図は従来に余長(ΔL)の中空系2. の長さ(L₁)に対する割合をとり(%)、同時に選別効率(選別によって分離した固形分量/総固形分量、%)をとって示したもので、この第4図から明らかなように余長(ΔL)の中空系2. の長さ(L₁)に対する割合が1以下になると選別効率が急激に悪化しているのがわかる。これは第2図にも示すように、選別にバフリングを行なう際には中空系2. がある程度屈曲する必要がある。従来に比べて固形分量が悪いとされるからである。さうに以下のことが観察された。すなわち余長(ΔL)の割合を1未満とした場合には、中空系2. の長さが必要以上に制限されるために、中空系膜フィルタ2の中心部の中空系2. 近傍に

多うは流路が狭通せず、よって外周部の中空系2aのみが流路に供される状態になってしまう。これは外周に設ける中空系2aのみに濾過分が付着することから回避することができる。それと同時に1流路とした場合には、濾過時に割断した図形分が中空系フィルタ2内に溜ってしまい、効果的に除去できないことが懸念された。このような理由から余長(ΔL)の中空系2aの長さ(L1)に対する割合の下置量を1としたものである。

以上本発明例によると以下のような効果を奏することができる。

- ①まず濾過時における中空系2aの引き上がり、それによってからみつき・屈曲あるいは割断するといった事態を効果的に防止することができる。
- ②次に濾過時には中空系2aが流路に通過するので、効果的な濾過が可能となる。
- ③また濾過時に割断した図形分が中空系フィルタ2内に溜ってしまうということもない。
- ④さらに濾過時にあっても中空系フィルタ2の

中心部に流通する中空系2aの回りにも濾過が効果的に流通するので、外周部のみで濾過が行われるといった事態を防止することができ、効率のよい濾過を奏することができる。

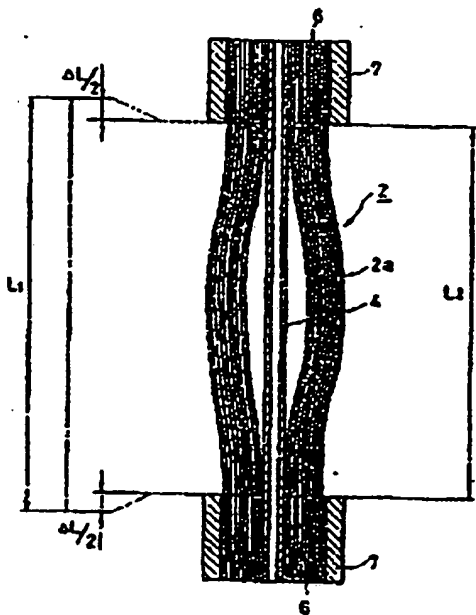
【発明の効果】

以上詳述したように本発明による中空系フィルタによると、中空系の引き上がり、それによつて、さらには屈曲・割断といった事態を防止することができるとともに、効果的な濾過を奏することができる等その効果は大である。

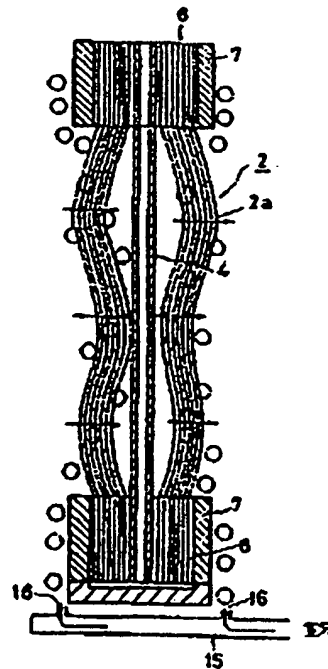
4. 図面の簡単な説明

第1図乃至第4図は本発明の一次実施を示す図で、第1図は中空系フィルタの正面図、第2図は濾過時の状態を示す中空系フィルタの正面図、第3図は中空系の余長を変化させた場合の図が本発明の要旨を示す特性図、第4図は中空系の余長を変化させた場合の濾過効率を示す特性図である。

2—中空系フィルタ、2a—中空系、4—支脚部、6—側面固定部、7—側面固定部、



第1図



第2図

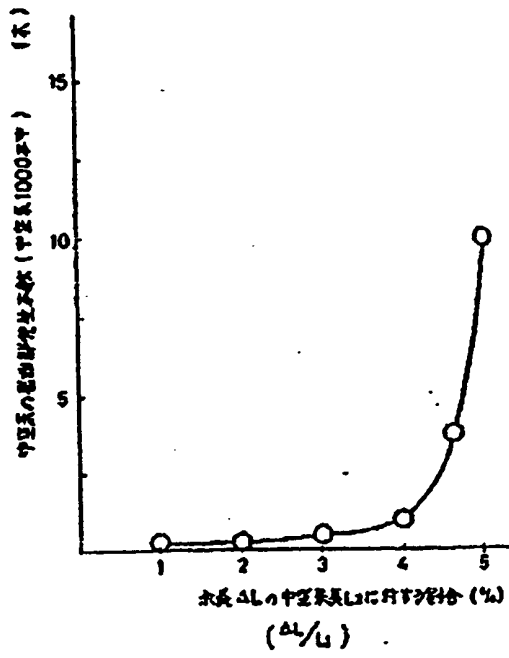


図 3

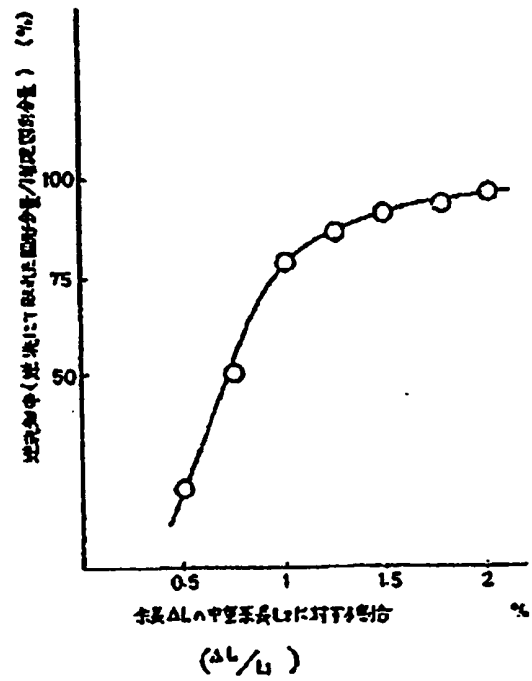


図 4

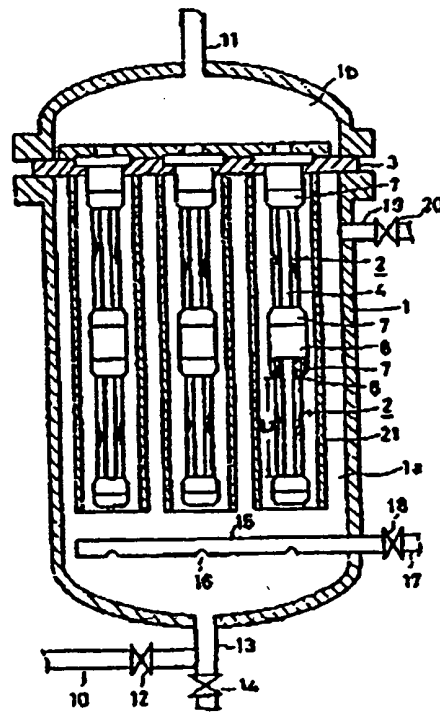


図 5



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(54) Title of Invention: Hollow Yarn Membrane Filter

(21) Application No.: Sho 61[1986]-292045

(22) Application Date: December 8, 1986 (Showa 61)

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Specification

1. Title of the Invention

Hollow yarn membrane filter

2. Claims

In the context of a hollow yarn membrane filter in which multiple pieces of hollow yarn are bundled, filling and securing with bonding agent are performed in such a

way that both bundled ends open, a bundle securing member is installed and secured at the outer circumference of the bonding agent filling sections filled with the aforesaid bonding agent, and the aforesaid bonding agent filling sections at both ends are connected across a specified length; a hollow yarn membrane filter characterized in that the length (L1) of the hollow yarn between the aforesaid two bonding agent filling sections is set so that there is a specified excess length (ΔL) with respect to the gap (L2) between the aforesaid two bonding agent filling sections, and this excess length (ΔL) satisfies the following conditions:

$$0.01 \leq (\Delta L/L1) \leq 0.04$$

where,

L1: The length of the hollow yarn arranged between the two bonding agent filling sections

L2: The gap between the two bonding agent filling sections

ΔL : (L1 - L2)

3. Detailed Explanation of the Invention

Objective of the Invention

Industrial Field of Usage

The present invention relates to a hollow yarn membrane filter used in water treatment apparatuses in various types of plants with the objective of separating and eliminating solid portions in the liquid to be treated.

Conventional Art

In general, the hollow yarn is a membrane of hollow cylindrical fiber which has small holes on its surface and whose outer diameter is approximately 0.3-3 mm. Therefore, it has benefits in that the filtration area per unit capacity is large, and pressure resistance is good. A filter is formed by bundling many pieces of the hollow yarn and hardening both ends with resin, which is a bonding agent. This hollow yarn membrane filter is used as a filtration device for water treatment apparatuses.

The structure of this type of hollow yarn membrane filtration device will be explained below while referring to Figure 5. Figure 5 is a cross-sectional diagram of a hollow yarn membrane filtration device, where callout 1 in the diagram is the container main unit. The interior of this container main unit 1 is split into top and bottom by a diaphragm 3, where the lower space is a filtration chamber 1a, and the upper space is a processing fluid chamber 1b. The hollow yarn membrane filter 2 is hanging down from the aforesaid diaphragm 3 within the aforesaid filtration chamber 1a. The aforesaid

hollow yarn membrane filter 2 has a structure whereby multiple pieces of hollow yarn 2a are bundled at the outer circumference of a support member 4, and their upper and lower ends are secured by bonding agent filling sections 6, and, in addition, bundle securing members 7 are installed and secured from the outer circumferences thereof. Also, in the apparatus shown in Figure 1, the hollow yarn membrane filter 2 with the aforesaid configuration is connected in two stages in a perpendicular direction, where callout 8 in the diagram is the connecting tube which is used when this is done. A fluid supply pipe 10 which connects with the filtration chamber 1a is connected to the lower end of the aforesaid container main unit 1 while a processing fluid discharge pipe 11 which connects with the processing fluid chamber 1b is connected to the upper end. A shut-off valve 12 is positioned along the aforesaid fluid supply pipe 10, and a concentrated fluid discharge pipe 13 is branch connected. A shut-off valve 14 is positioned along this concentrated fluid discharge pipe 13. The fluid which has been supplied to the interior of the filtration chamber 1a via the aforesaid fluid supply pipe 10 is filtered when it passes through the hollow yarn membrane filter 2, and it is discharged via the hollow sections of the respective pieces of hollow yarn 2a.

In the aforesaid configuration, when the differential pressure before and after the hollow yarn membrane filter 2 rises due to filtration and reaches a specified value, a backwash operation is executed to perform an operation to wash off the solid portion which has adhered to the surfaces of the respective pieces of hollow yarn 2a. That is, a pressurized gas for backwashing is supplied inside the respective pieces of hollow yarn 2a of the hollow yarn membrane filter 2 via the aforesaid processing fluid discharge pipe 11. Simultaneously, a bubbling operation is executed from below the hollow yarn membrane filter 2. That is, a bubbling pipe 15 is arranged below the hollow yarn membrane filter 2 within the aforesaid container main unit 1, and bubble holes 16 are formed in the lower surface of this bubbling pipe 15. The aforesaid bubbling pipe 15 is connected to an air supply pipe 17 which has a shut-off valve 18. By supplying air to the aforesaid bubbling pipe 15 via the aforesaid air supply pipe 17, bubbles are generated from the aforesaid bubble holes 16. The hollow yarn membrane filter 2 is subject to bubbling by the aforesaid bubbles to improve the washing effect. An overflow pipe 19 is connected to the container main unit 1 so that it is positioned below the aforesaid diaphragm 3, and a shut-off valve 20 is positioned along said overflow pipe 19. Callout 21 in the diagram is a protecting tube, and this protecting tube 21 which allows the bubbles from the aforesaid bubbling to be effectively introduced into the hollow yarn membrane filter 2.

The current situation is such that, when backwashing is performed on a hollow yarn membrane filter 2 with the aforesaid configuration, the question of what degree of excess length should be set for the length (L1; a value larger than L2, since there is some looseness in the gap which is the aforesaid L2) of the hollow yarn 2a arranged between the two ends with respect to the distance (shown by callout L2 in Figure 5) between the two ends, which was determined according to the bonding agent filling sections 6 at both ends, in order to effectively perform the aforesaid bubbling and prevent damage to the hollow yarn 2a has not been taken into account. Conventionally, it has been set with

excess length of approximately 5 percent. However, situations in which the multiple pieces of hollow yarn 2a become twisted then bent and damage have occurred as filtration and backwashing were repeated. This is thought to be because the hollow yarn 2a consists of a polymeric material, and its specific gravity is almost equal to that of water, which is the main constituent of the processed fluid, so the hollow yarn 2a whirls up, then bends and becomes damaged. As a means of solving these types of problems, the excess length, which has been set to approximately 5 percent as mentioned above, may be shortened or eliminated. However, the following problems occur when such a method is adopted.

1) First, when the range of oscillation of the hollow yarn 2a when the aforesaid bubbling is performed is restricted more than is necessary, it is impossible to obtain a sufficient bubbling effect.

2) When the hollow yarn membrane filter 2 is bundled in the aforesaid way in a condition in which multiple pieces of hollow yarn 2a are densely arranged, and the excess length is decreased, the effects are such that the fluid to be processed does not flow efficiently between the respective pieces of hollow yarn 2a, and, therefore, only the hollow yarn 2a which is positioned at the outer circumference of the hollow yarn membrane filter 2 is provided for filtration. This is also undesirable from the standpoint of filtration efficiency, and it results in a phenomenon by which solid portion adheres only to the hollow yarn 2a positioned at the outer circumference.

3) Also, when backwashing is executed, there is a problem in that the solid portion which has been separated by said backwashing accumulates among the pieces of hollow yarn 2a, and removal of the separated solid portion is not performed effectively. This is because, ultimately, the flow characteristics among the pieces of hollow yarn 2a are poor because the hollow yarn 2a is densely arranged in the same way as the aforementioned 2), and the excess length is short.

Problems To Be Solved By the Invention

In this way, in conventional hollow yarn membrane filters, there has not been sufficient study with respect to how to determine the excess length, resulting in various problems. The present invention was designed taking these points into account, and its objective is to provide a hollow yarn membrane filter equipped with an excess length which makes it possible to perform effective backwashing while preventing damage to the hollow yarn.

Configuration of the Invention

Means To Solve Problems

In the context of a hollow yarn membrane filter in which multiple pieces of hollow yarn are bundled, filling and securing with bonding agent are performed in such a way that both bundled ends open, a bundle securing member is installed and secured at

the outer circumference of the bonding agent filling sections filled with the aforesaid bonding agent, and the aforesaid bonding agent filling sections at both ends are connected across a specified length; the hollow yarn membrane filter of the present invention is characterized in that the length (L1) of the hollow yarn between the aforesaid two bonding agent filling sections is set so that there is a specified excess length (ΔL) with respect to the gap (L2) between the aforesaid two bonding agent filling sections, and this excess length (ΔL) satisfies the following conditions:

$$0.01 \leq (\Delta L/L1) \leq 0.04$$

where,

L1: The length of the hollow yarn arranged between the two bonding agent filling sections

L2: The gap between the two bonding agent filling sections

ΔL: (L1 - L2)

Action

Setting the excess length of the hollow yarn within the aforesaid range effectively solves such problems as the drop in the backwashing effect which occurs due to the excess length being too small as it eliminates the bending and damage which result from the twisting of the hollow yarn which occurs due to the excess length being too great.

Embodiments

An embodiment of the present invention will be explained while referring to Figures 1 through 4. The same portions as in the conventional example are indicated by the same callouts, and explanations of these portions have been omitted. Figure 1 is a cross-sectional diagram of the configuration of the hollow yarn membrane filter 2, where the length (L1) of the hollow yarn 2a arranged between the two bonding agent filling sections 6 at the top and bottom ends in a condition which is somewhat loosened has an excess length (ΔL) with respect to the distance (L2) between the aforesaid two bonding agent filling sections 6, and this excess length (ΔL) is set within the following range. $0.01 \leq (\Delta L/L1) \leq 0.04 \dots (1)$

where,

L1: The length of the hollow yarn arranged between the two bonding agent filling sections

L2: The gap between the two bonding agent filling sections

ΔL: (L1 - L2)

The reason that the excess length (ΔL) is set within this range is to effectively eliminate both the harmful effects resulting from the excess length being too great and the harmful effects resulting from the excess length being too small, which will be explained below while referring to Figures 3 and 4.

Figure 3 shows the proportion (%) of the excess length (ΔL) with respect to the length (L_1) of the hollow yarn 2a on the horizontal axis and the number of bent sections of the hollow yarn 2a (among 1,000 pieces of yarn) on the vertical axis. According to this diagram, when the proportion of the excess length (ΔL) with respect to the length (L_1) of the hollow yarn 2a is 4 or less, the number of pieces of hollow yarn 2a in which bent sections have occurred is extremely small. Therefore, if the excess length (ΔL) proportion is set to 4 or less, it is possible to effectively eliminate harmful effects resulting from the excess length being large. The lower limit value will be explained while referring to Figure 4. Figure 4 shows the proportion (%) of the excess length (ΔL) with respect to the length (L_1) of the hollow yarn 2a on the horizontal axis and the backwashing efficiency (solid portion volume separated by backwashing / captured solid portion volume, %) on the vertical axis. As we can see from Figure 4, when the proportion of the excess length (ΔL) with respect to the length (L_1) of the hollow yarn 2a is 1 or less, backwash efficiency quickly deteriorates. As shown in Figure 2, this is because it is necessary for the hollow yarn 2a to oscillate to certain extent when bubbling is performed during backwashing, and the solid portion gets shaken off by said oscillation. Moreover, the following has been observed. Because movement of the hollow yarn 2a is limited more than is necessary when the excess length (ΔL) proportion has been set to less than 1, filtrate does not flow in the vicinity of the hollow yarn 2a of the center section of the hollow yarn membrane filter 2, resulting in only the outer circumference portion of the hollow yarn 2a being provided for filtration. This may be observed from the fact that the solid portion only adheres to the hollow yarn 2a positioned at the outer circumference. It has also been confirmed that when a setting of less than 1 is used simultaneously with this, the solid portion which has been separated during backwashing flows into the hollow yarn membrane filter 2 and cannot be effectively removed. For this reason, the proportion of the excess length (ΔL) with respect to the length (L_1) of the hollow yarn 2a has been given a lower limit value of 1.

The above embodiment is able to exhibit the following benefits.

- 1) First, it is possible to effectively prevent the situation whereby the hollow yarn 2a whirls up during backwashing and therefore becomes twisted and bent or damaged.
- 2) Also, effective backwashing becomes possible due to the hollow yarn 2a oscillating to an appropriate degree during backwashing.
- 3) In addition, the solid portion separated during backwashing does not flow into the hollow yarn membrane filter 2.

4) Also, filtrate flows efficiently even around the hollow yarn 2a positioned at the center section of the hollow yarn membrane filter 2 even during filtration, so it is possible to prevent the situation whereby filtration is only performed at the outer circumference section and to provide effective filtration.

Benefits of the Invention

As explained in detail above, through the hollow yarn membrane filter resulting from the present invention, there are great benefits in that it is possible to prevent the situation whereby the hollow yarn whirls up and therefore becomes twisted and bent or damaged and to provide effective backwashing.

4. Brief Explanation of the Figures

Figures 1 through 4 are diagrams which show an embodiment of the present invention, where Figure 1 is a front view of a hollow yarn membrane filter; Figure 2 is a front view of a hollow yarn membrane filter which shows the action during backwashing; Figure 3 is a characteristics diagram which shows changes in the number of pieces in which bent sections occur when the excess length of the hollow yarn is changed; Figure 4 is a characteristics diagram which shows changes in the backwashing effect when the excess length of the hollow yarn is changed; and Figure 5 is a cross-sectional diagram of a hollow yarn membrane filtration apparatus.

- 2 Hollow yarn membrane filter
- 2a Hollow yarn
- 4 Support member
- 6 Bonding agent filling section
- 7 Bundle securing member

Figure 1

Figure 2

- 1. Air

Figure 3

- 1. The number of pieces of hollow yarn in which bent sections occur (per 1,000 pieces of hollow yarn) (pieces)
- 2.

The proportion of excess length (ΔL) with respect to the length L_2 of the hollow yarn (%)

Figure 4

3. Backwashing efficiency (solid portion volume separated by backwashing/captured solid portion volume) (%)
4. The proportion of excess length (ΔL) with respect to the length L_2 of the hollow yarn

Figure 5

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